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DV Coding: How it Works with IEEE-1394

Dateline: 3/26/98

by Thomas "Rick" Tewell
VP of Engineering
Sequoia Advanced Technologies
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 -David Simpson

DV Coding: How it works with IEEE-1394

Presented July 29, 1997

Thomas "Rick" Tewell

VP of Engineering

Sequoia Advanced Technologies

What is DV?

- * DV is a compressed digital video and audio recording standard
- * DVC is an abbreviation for Digital Video Cassette
- * MiniDV is a small DV consumer cassette.
- * DV is endorsed by over 50 major manufacturers.
- * It is not DVD!!!

What are the tape specs?

- * 6.35 mm (1/4") magnetic tape
- * MiniDV cassettes (used in digital camcorders) hold up to 60 minutes of audio/video
- * Standard DV cassettes (Sony calls DVCAM) hold up to 180 minutes of audio/video
- * 60 minute MiniDV cassette holds almost 13 gigabytes of digital data!
- * 180 minute DV cassette holds almost 39 gigabytes of digital data!
- * Effective data rate is 3.6 MB/sec continuous



Compressed Video Specs

- * Compresses a 720 x 480 4:1:1 YUV image to 103,950 bytes (ratio 4.9: 1)
- * Intra-frame DCT based compression
- * Ideal for video editing solutions
- * Operates at 30 frames per second
- * Effective video transmission rate is 3.12 MB/sec

What does DV have to do with IEEE-1394?

- * The hot new digital camcorders use IEEE-1394 to transport DV data

How do I get DV data into my computer?

It is a two step process.

- * Capture the DV Data
- * Decode the DV Data

Capturing DV Data

- * Most 1394 digital camcorders broadcast DV data on isochronous channel 63
- * Set tag bit to 01 when you listen on Isochronous channel 63

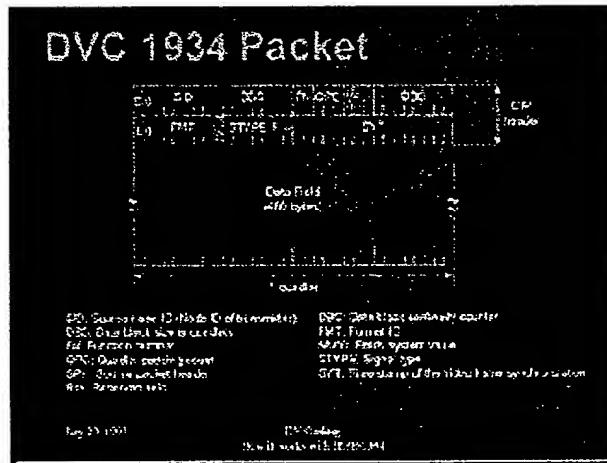
This usually results in a 'channel' specification of 127 with most Windows 95 IEEE-1394 APIs

- * DV data packets are 488 bytes long

8 bytes of CIP header and
480 bytes of DV data

* You must look for the start of a video frame as these 488 byte packets come across the 1394 bus

We look for the 16-bit value
0x1F07 at byte offset 0x08 to
determine if we have the first
packet of a video frame



- * Once you have start of frame you must collect the next 250 valid packets of data to have a complete DV frame
- * Every 15th packet is a null packet and should be discarded

Adaptec and TI handle null packets with their Windows 95 API differently so care must be taken here!

- * Once you have 250 valid packets of data in a buffer you must cycle through the packets and discard the CIP headers
- * If all went well, you should have a buffer with a 120,000 byte DV frame in it!

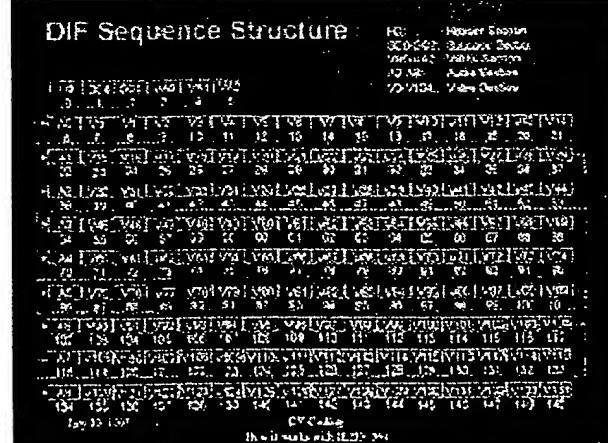
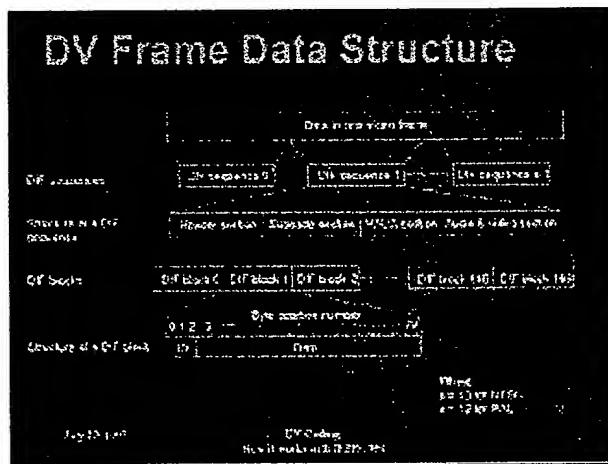
Decoding DV Data

- * A NTSC DV frame (720 x 480) is divided into 10 DIF (data in frame) sequences each 12,000 bytes long
- * One DIF sequence contains five super blocks of video pixel data
- * There are 150 DIF blocks of 80 bytes each in each DIF sequence

135 DIF blocks are used for video information

9 DIF blocks are used for audio information.

6 DIF blocks are used for Header, Subcode and Video Auxiliary (VAUX) information



Decoding DV Data (continued)

* DV video frames are organized into 270 individual video segments

27 video segments per DIF sequence

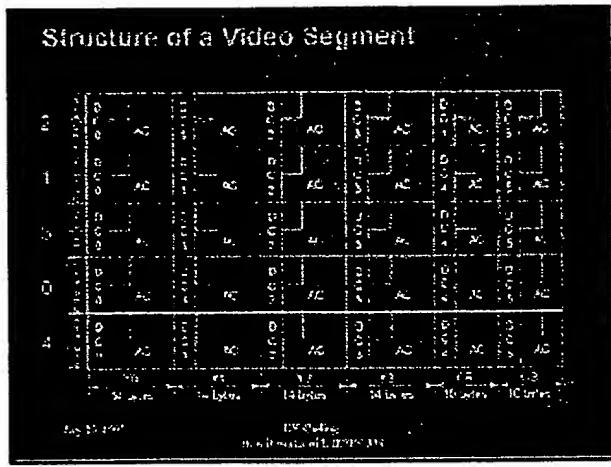
* A video segment is made up of 5 compressed macro blocks

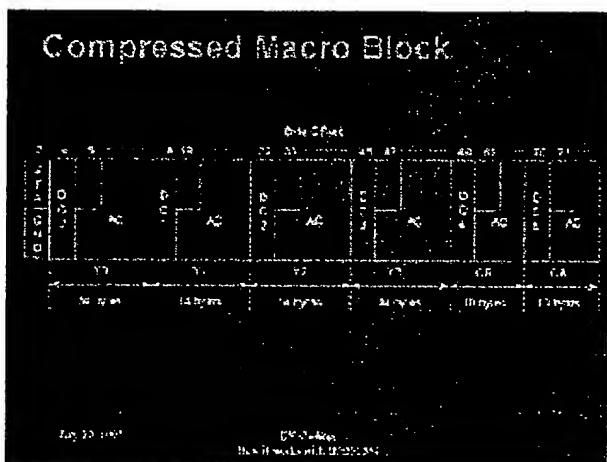
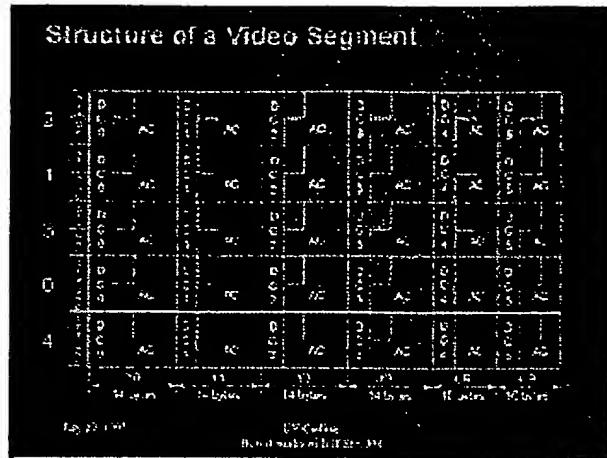
A macro block is 80 bytes long

3 bytes for DIF
block ID
information
14 bytes each for
Y0, Y1, Y2 and
Y3

10 bytes each for
CR and CB
1 byte for the
quantization
number (QNO)
and block status
(STA)

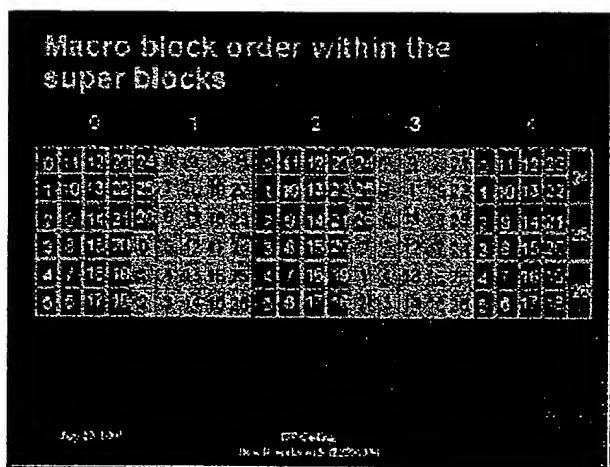
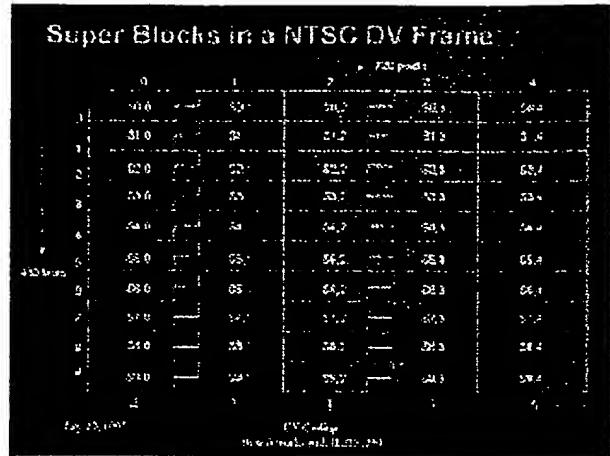
* Each macro
block represents
a 32 x 8 pixel
region taken from
each of five
'columns' of the
video frame



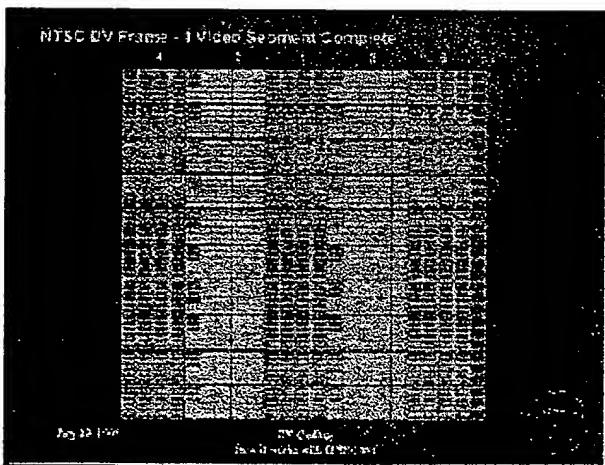


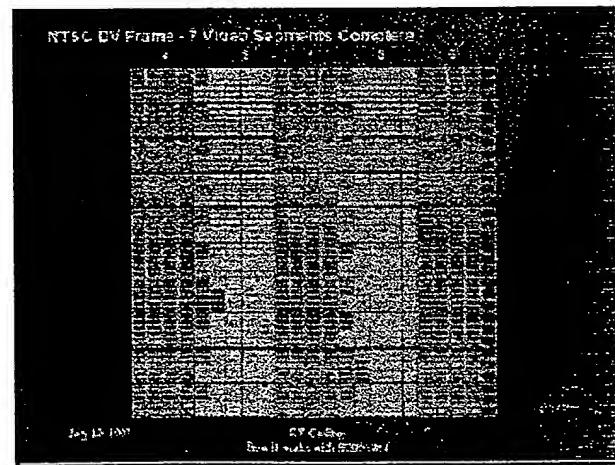
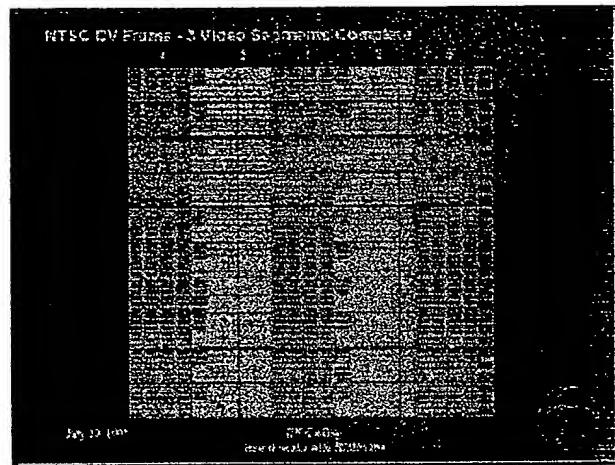
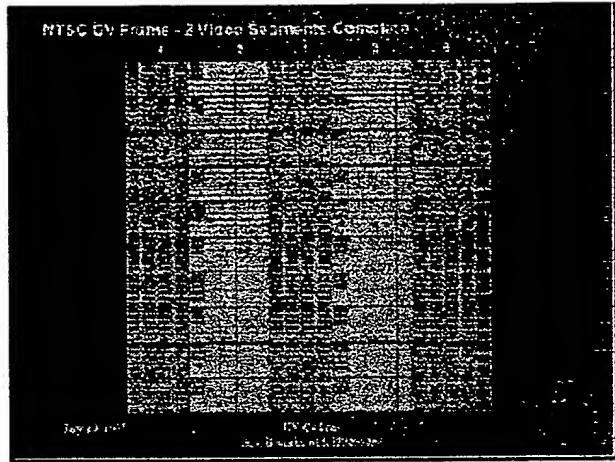
Super blocks

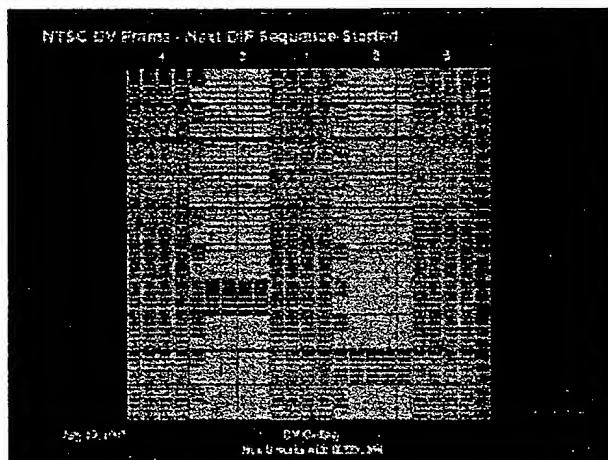
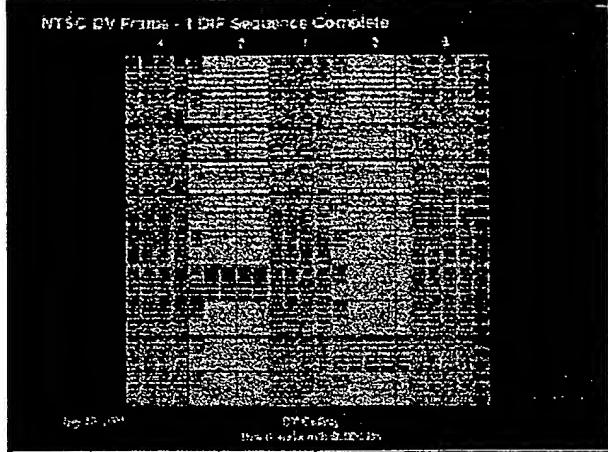
- * Super blocks are a logical organization of 27 macro blocks
- * There are 50 super blocks in a NTSC DV video frame
- * A group of 5 super blocks (1 from each super block column) make up one DIF sequence



The building of a NTSC DV frame







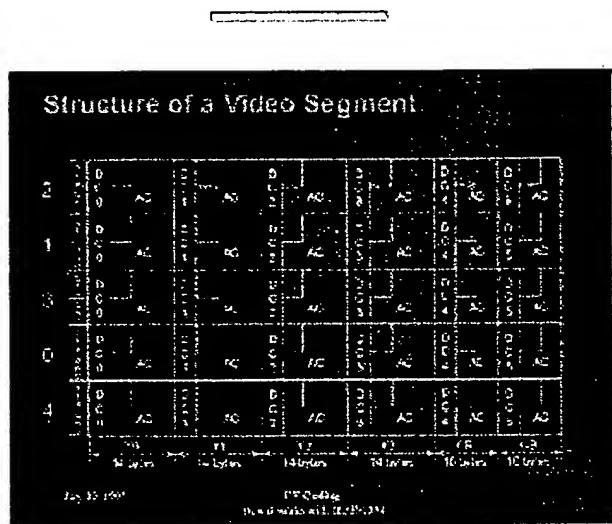
Decoding DV Data (continued)

* Decoding a video segment (a group of 5 related compressed macro blocks)

Extract AC coefficients via a three pass variable length decoding algorithm

Pass 1: decode
VLC AC
coefficients for
Y0, Y1, Y2, Y3,
CR and CB within
a macro block
Pass 2: decode
overflowed VLC
AC coefficients
within a macro
block

Pass 3: decode overflowed VLC AC coefficients within a video segment



Decoding DV Data (continued)

* Once you have AC coefficients:

Inverse quantization
Zigzag coefficient output
ordering
Inverse weighting
Inverse Discrete Cosine
Transform (DCT) either 8-8
or 2-4-8
2-4-8 is used when there is
lot of detail in the pixel group
Store the pixel values in the
proper location in the video
frame

- * Every 3 video segments you must be sure to skip the audio DIF block
- * Every 27 video segments you must be sure to skip the header, subcode and VAUX DIF blocks (6 total)
- * Do the previous video segment decoding sequence 270 times and you have a YUV 4:1:1 - 720 x 480 video

frame!

More information?

* **DVC "Blue Book"**

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Tel 81-6-905-4023, Fax
81-6-906-8125

* 1394 TA website

* Global DVC Club website

* DVC & Firewire central website

* Sequoia website

Sequoia Advanced Technologies

- * Developer of IEEE-1394 consumer level system software specializing in Windows 95 and Windows NT
- * Developed a high quality DVC codec for decoding and encoding DVC frames
- * Has a full IEEE-1394 DV solution for Windows 95 and Windows NT

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